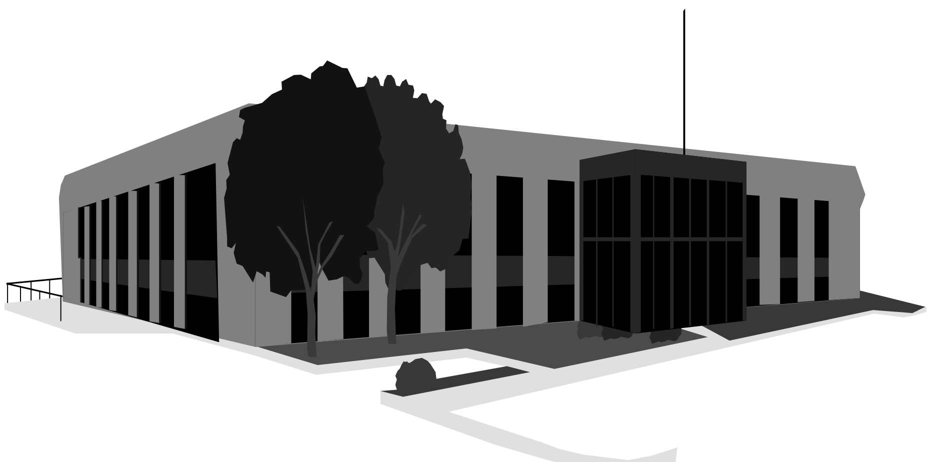
INDOOR AIR QUALITY ASSESSMENT
Related to Sewer Gas Odors in Selected Areas

J. C. Solomonese Elementary School
315 West Main Street
Norton, Massachusetts



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
May, 2001

Background/Introduction

At the request of Robert Curry of the Norton Board of Health, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the J.C. Solomonese Elementary School, 315 West Main Road, Norton, Massachusetts. On February 16, 2001, a visit was made to this school by Michael Feeney, Chief of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA to conduct an indoor air quality assessment. Chronic problems with sewer gas odors in the kitchen and cafeteria prompted this request. Staff reported symptoms of eye irritations, lightheadedness and headaches associated with the odor. Staff also reported that the odor appeared to be strongest during time of peak kitchen sink/drain usage (approximately noontime).

The school consists of two wings constructed in 1978. The single story wing contains the kitchen, cafeteria and kindergarten classrooms. The two-story wing contains general classrooms. Windows are openable.

School department officials reported that a sewer odor was detected in a kitchen storeroom. Inside the interior wall of the south section of the storeroom are three sewer vent pipes that terminate on the roof of the kitchen. School officials reported that one of these pipes had split and was recently replaced. However, sewer odors continued to be reported in the kitchen area during school hours.

School officials also reported problems with sewer odors in other areas of the building, including the kindergarten wing and mechanical room penthouse on the roof of the two-story wing. This assessment consists of an examination of these three areas exclusively, to identify potential sewer gas pathways into occupied areas of the building.

Methods

Visual inspection of each area was conducted, with an examination of wall interiors and ceiling plenums of the kitchen storeroom and kindergarten classrooms. The interior of the penthouse air-handling unit (AHU) was also examined.

Results

This school has approximately 840 students and an employee population of approximately 80. The building was examined under normal operating conditions.

Discussion

Ventilation

Complaints of stagnant air were reported in room 20. There are several conditions that can contribute to this condition.

1. General exhaust ventilation in this classroom is provided by a vent located in the upper portions of a storage closet (Picture 1). It appears that classroom air is drawn through a space beneath the closet door (see Figure 1). This design allows for the vent to be easily blocked by stored materials (see Figure 2/ Picture 2). In addition, the space beneath the door appears to be insufficient for the draw of exhaust air from the classroom.
2. A unit ventilator provides fresh air for this classroom. Above the fresh air diffuser is a passive vent installed in the ceiling (see Picture 3). This passive vent opens into the ceiling plenum for no discernable purpose. As the univent

operates, air is forced up into the ceiling plenum through this passive vent. This can result in the creation of positive pressure of the ceiling cavity, which can result in air moving from the ceiling cavity back into the classroom. A positively pressurized ceiling plenum can result in dust, dirt and other pollutants being forced through the ceiling plenum into the classroom.

3. The lack of sufficient space beneath the classroom's restroom door also limits exhaust air from being removed from the classroom.

Each of these conditions can contribute to the physical sensation of still air. Without proper dilution and removal by the mechanical ventilation systems, normally occurring environmental pollutants can build up and lead to indoor air complaints in this area.

Moisture Concerns

The interior of the penthouse AHU was evaluated while operating during cool weather. Since this AHU has air-conditioning capacity, the use of the ventilation during warm weather can result in the generation of condensation. As outdoor air is drawn over cooling coils in the AHU, moisture in the form of condensation is generated. As condensation collects, water droplets are formed which drip from the cooling coils. Condensation is collected in drip pans beneath the cooling coils. Drip pans direct collected water from the AHU into a floor drain in the penthouse. The surface of the drip pan and AHU casing appeared to be severely corroded. Cooling coil fins were corroded near the base of the unit, accompanied by scale and debris. The floor of the AHU also appeared to be coated with accumulated dirt and debris. Insulation installed on the interior surface of the AHU casing was found torn and degrading (see Picture 4).

Standing water in drip pans, moistened debris on the floor of the AHU and repeatedly wetted insulation can all serve as growth media for mold. If mold growth occurs, spores and odors can be transported into the interior of the building via the heating, ventilating and air-conditioning (HVAC) system.

The penthouse AHU is also equipped with a humidification system. Humidification equipment, if not maintained, can be a source of moisture in an HVAC system and a source of microbial growth. According to building staff, the humidification system has not functioned for some time. The interior of the ductwork connected to the humidification system could not be examined during the assessment. If repairs are not made to the humidification system to restore its function, it is advised to remove the system from the ventilation ductwork.

Sewer Gas Odor Pathways

Town officials indicated that the plumbing in the kitchen was previously tested. Spearmint oil was poured into the sewer vents and drains of the kitchen area on a weekend previous to the BEHA assessment. Town officials within the kitchen area during this test reportedly detected no spearmint odor.

Sewer gas odors were noted in the kitchen storeroom around the sewer vent pipes. Two conditions appear to contribute to this odor in the building. In the north section of the storeroom, a ceiling-mounted exhaust vent was found to be backdrafting cold air instead of drawing air. The motor for this exhaust vent appeared to be broken. South of the exhaust vent motor is the termini of the three kitchen sewer gas vents. All three sewer vents terminate two feet above the roof. Hydrogen sulfide (HS), a gas that is a constituent of sewer gas, is heavier than air. A south wind in cold weather can direct HS towards the exhaust vent and into the storeroom.

A second means for sewer gas odors was also identified. Sewer gas odors were noted around the vent pipes, which appeared to be enhanced once all kitchen faucets were running. The replaced vent pipe was joined to the floor pipe by a rubber-lined metal collar (see Picture 5). The newly installed steel pipe appeared to be slightly off-line with the floor pipe. This mismatched alignment resulted in bending the rubber-lined clamp, creating a space to the interior of the vent pipe. Drafting air from the pipe collar was visually confirmed by dropping flour along the exterior of the pipe. Flour was seen moving away from the bottom edge of the pipe collar, indicating air movement from the pipe.

Contributing to this air movement is the operation of the kitchen exhaust vent hood. The center of the kitchen has a large, operational exhaust vent hood, which creates negative pressure to draw cooking odors, heat and other pollutants out of the kitchen. Negative air pressure created by the vent hood also draws air from areas surrounding the kitchen. With the integrity of the sewer vent pipe compromised, the operation of the kitchen exhaust vent hood can draw sewer gas odors into the kitchen area. The operation of the kitchen exhaust vent hood can also enhance the draw of backdrafting air through the disabled exhaust vent in the kitchen storeroom.

Sewer gas odors were also detected in restrooms throughout the kindergarten wing. Each classroom is outfitted with an exhaust vent. The usual design of these restrooms is to have either a passive vent installed within the door or have a space approximately one inch wide for the exhaust vent to draw air from the classroom. The draw of air from the classroom (called transfer air) allows for the creation of airflow through the restroom to the exhaust vent, thereby removing odors and water vapor. Without sufficient transfer air, negative air pressure created by the exhaust vents can draw air from all available sources, including holes in walls, and in this case air from beneath the toilets. Pipe chases behind toilets were found free of sewer gas odor, which indicates the source of odors is the toilet. Each toilet is also connected to a sewer venting system. If the base of the toilet is not airtight, sewer gas odors can be drawn from underneath the toilet. As an example, one kindergarten classroom restroom had a detectable sewer gas odor upon opening its door. The exhaust vent quickly cleared the odor when the door remained open. After the restroom was closed for several minutes and reopened, the sewer gas odor returned. This condition indicated that with adequate transfer air, the restroom exhaust vent removed odors from restrooms. Restrooms in the two-story wing were examined. These restrooms do not have doors, but have entrances configured in a zigzag pattern to obscure the interior from the hallway. Exhaust vents were operational and no sewer gas odor was detected in these restrooms, since transfer air from the hallways is readily drawn into each restroom through the zigzag entrance.

School staff indicated that the two-story wing had experienced sewer gas odors previously, presumably from AHU entrainment from rooftop sewer vent pipes. Efforts to prevent sewer gas odor included extending sewer vents to the west of the penthouse with PVC pipe (see Picture 6) and sealing sewer vents to the north of the fresh air intake of the penthouse AHU. The most likely source of sewer odor entrainment is the condensation drain of the AHU. The mechanical room penthouse contains an AHU that services the interior classrooms of the two-story wing. This AHU is equipped to provide air-conditioning during warm weather months. As mentioned previously, AHUs that provide air-conditioning require the installation of condensation drains to prevent water build up inside the casing and ductwork. The condensation drains for these units terminate above a floor drain that is connected to the building drainage system.

Drains are usually designed with traps in order to prevent sewer odors/gases from penetrating into occupied spaces. When water enters a drain, the trap fills and forms a watertight seal. Without periodic input of water (e.g., every other day), traps can dry and compromise the integrity of the watertight seal. If traps dry out, odors or other material can travel up the drain and be distributed to occupied areas by the ventilation system. Both the floor drains and condensation drains have traps.

During this assessment, the AHU was found to be drawing air through the condensation drains. This condition occurs because no water is produced by the AHU during the heating season to create a watertight seal in the condensation drain. With each condensation drain acting as a vacuum, odors from floor drains without water-sealed traps can be drawn into the AHUs and distributed to occupied areas within the building. This condition was discovered by the school custodian, who reportedly pours water down the penthouse floor drain routinely to prevent the trap from drying. Repeated wetting of the drain trap has reportedly reduced or eliminated sewer gas odors in this area.

The penthouse AHU has wire mesh installed as filters (see Picture 7). These wire mesh screens are designed to prevent large objects from entering the AHU chamber and fans and do not filter respirable dusts from the air stream drawn into each AHU. This can result in dust, dirt and other debris being distributed by the ventilation system. AHUs are normally equipped with filters that strain particulates from airflow. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent would be sufficient to reduce airborne particulates (Thornburg, D., 2000; MEHRC, 1997; ASHRAE, 1992). Note that increased filtration can reduce airflow produced by the AHU by increased resistance. Prior to any increase of filtration, the AHU should be evaluated by a ventilation engineer to ascertain whether it can maintain function with more efficient filters.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Reseal/replace the sewer vent in the kitchen storeroom to render this pipe airtight. [This activity was reported to be completed (NPS, 2001)].
2. Extend the kitchen sewer vent pipes in a manner similar to the sewer vent pipes on the western side of the two-story wing roof. [This activity is planned (NPS, 2001)].
3. Repair the kitchen storeroom exhaust vent and operate during school hours.
4. As suggested by school custodial staff, seal the base of kindergarten toilets with a sealant to provide an airtight seal.

5. Examine the feasibility of either increasing the space beneath doors or install a passive door vent to provide adequate transfer air for kindergarten restrooms.
6. Remove stored materials blocking the beneath-the-door space of the storage closet in room 20. Examine the feasibility of: increasing the space beneath the closet door, installing a passive door vent or moving the exhaust vent from the ceiling of the closet to the wall above the closet door.
7. Replace the ceiling mounted grate above the room 20 univent with a ceiling tile.
8. Continue to routinely pour water into the floor drain of the penthouse.
9. Clean accumulated debris from the floor of the AHU cabinet. Consider having the coils cleaned by an HVAC contractor. Remove and replace abraded fiberglass insulation on the interior of the AHU.
10. Consider removing the unused humidification equipment from the AHU ductwork.
11. Consider replacing wire mesh screens on the penthouse AHU with filters that have an increased dust spot efficiency to remove particles from the air stream.
12. Based on the conditions noted in the penthouse AHU, the Bureau of Environmental Health Assessment would recommend that a complete indoor air quality assessment be conducted at the J. C. Solomonese Elementary School after the AHU air-conditioning system is activated.

References

ASHRAE. 1992. Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 52.1-1992.

MEHRC. 1997. Indoor Air Quality for HVAC Operators & Contractors Workbook. MidAtlantic Environmental Hygiene Resource Center, Philadelphia, PA.

NPS. 2001. Letter to Michael Feeney, BEHA, MA Department of Public Health from Roy Bain, Director of Facilities, Norton Public Schools, concerning air quality at the J. C. Solomonese Elementary School, dated March 1, 2001. Norton Public Schools, Norton, MA.

Thornburg, D. Filter Selection: a Standard Solution. *Engineering Systems* 17:6 pp. 74-80.

Figure 1: **Designed Configuration of Airflow into the Closet Exhaust Vent (Side View)**

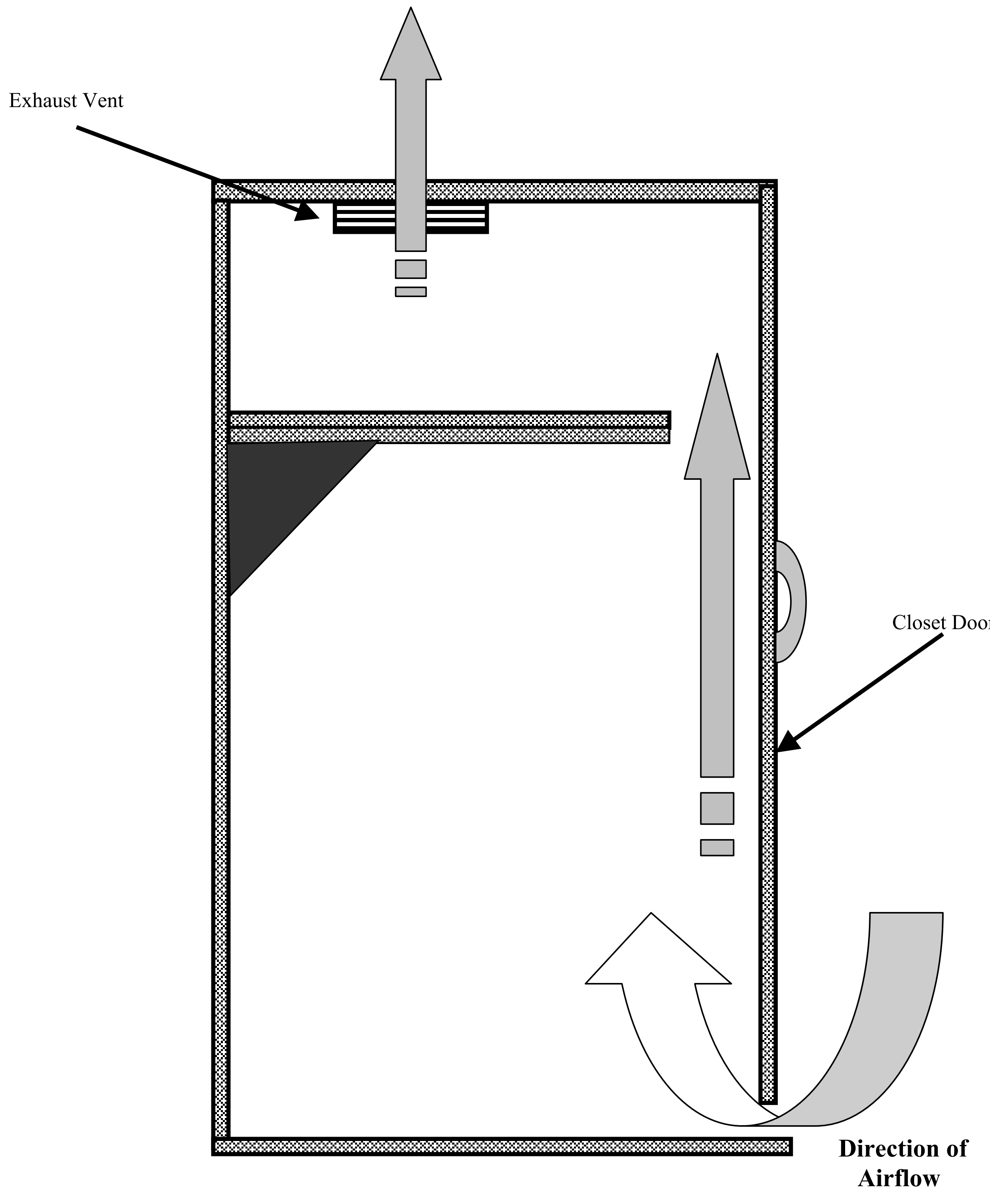


Figure not Drawn to Scale

Figure 2: **Blockage of Airflow into the Closet Exhaust Vent (Side View)**

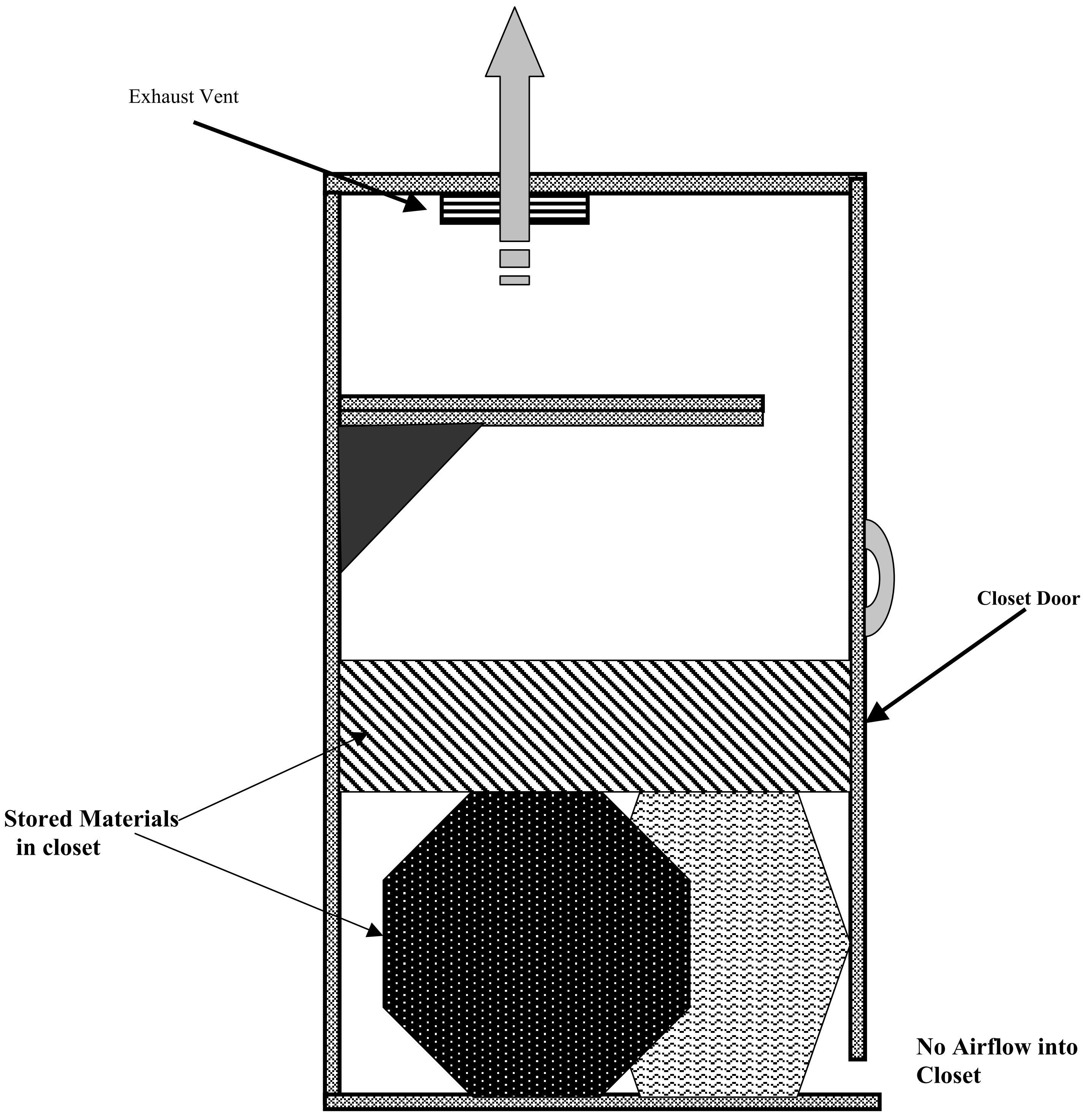
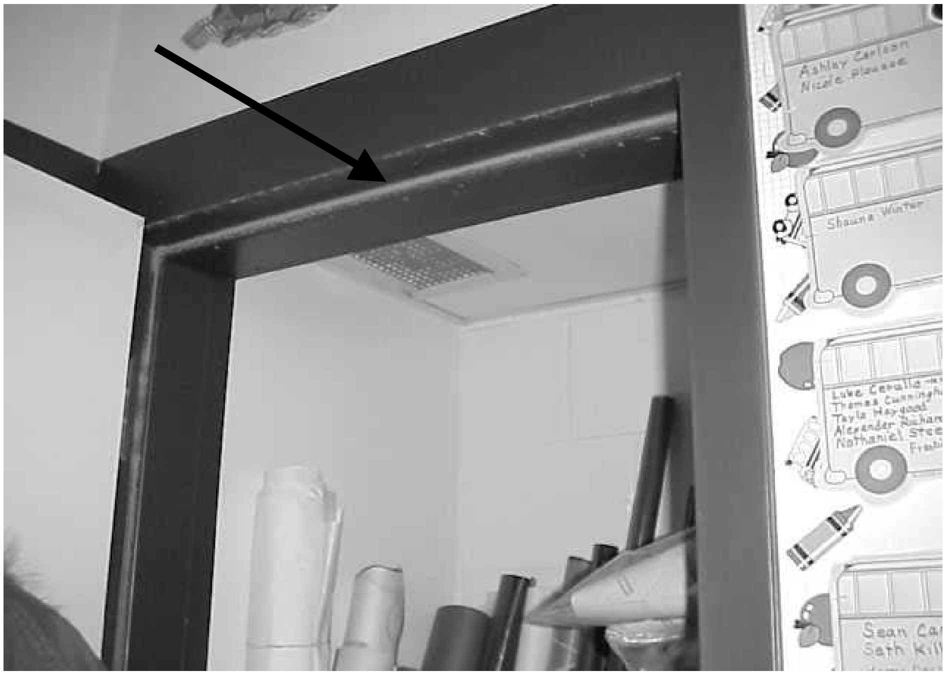


Figure not Drawn to Scale

Picture 1

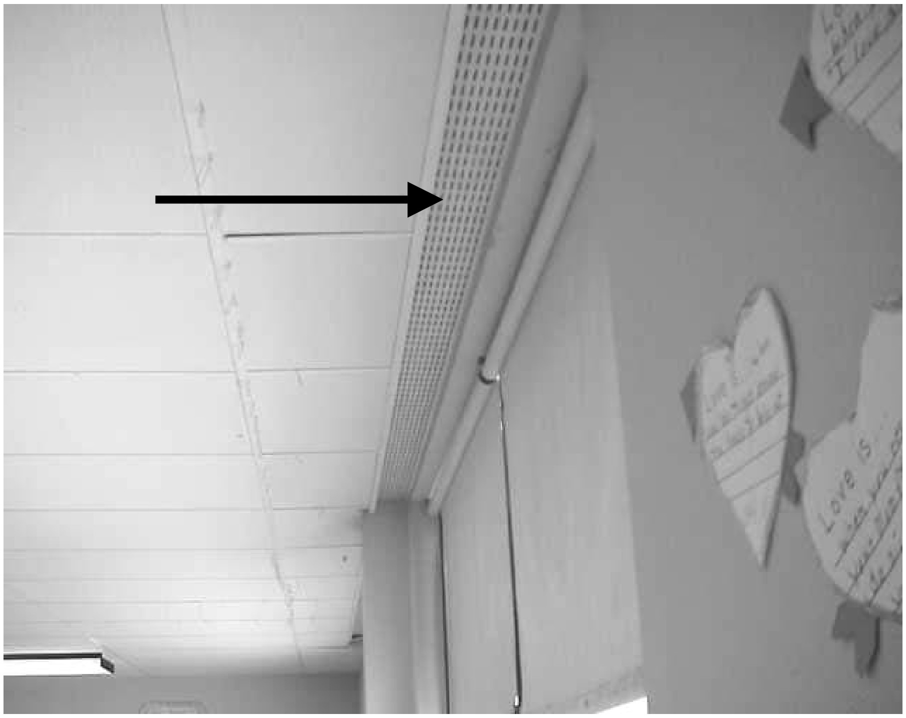


Room 20 Exhaust Vent in Closet, Note Heavy Coat of Dust on the Door Frame, Which Indicates Airflow into the Closet through the Doorframe

Picture 2

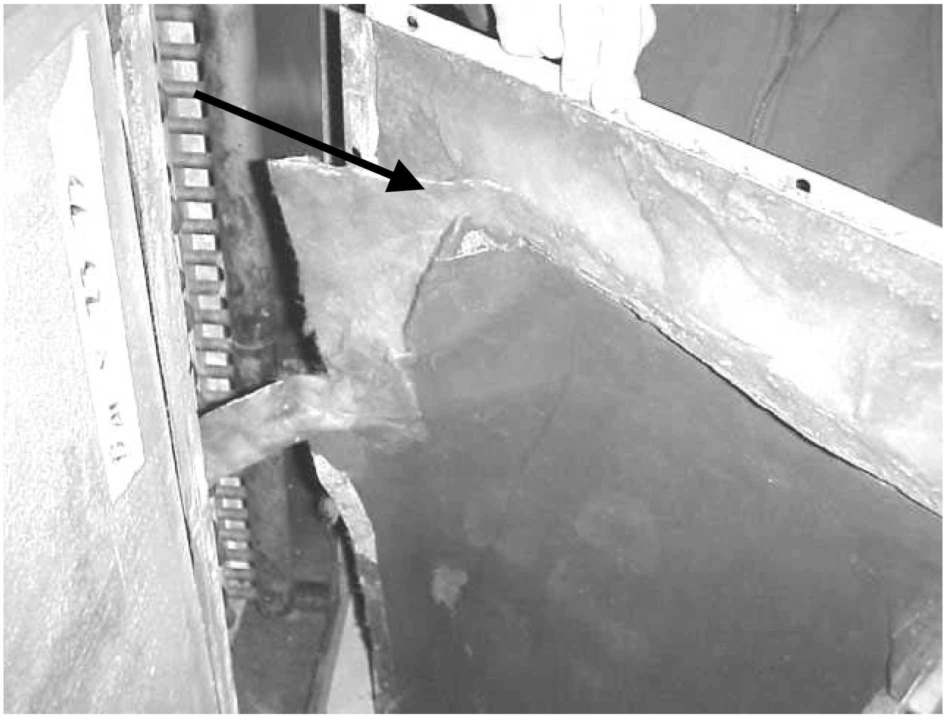
Bottom of Closet Door Blocked with Stored Materials in Room 20

Picture 3



Passive Ceiling Vent over Room 20 Unit Ventilator

Picture 4



Torn Insulation on AHU Access Lid

Picture 5

Metal Collar Connecting Sewer Vent Pipes

Picture 6

Extended Sewer Vent Pipes on Western Section of the Two-Story Wing Roof

Picture 7

Wire Mesh Screens in the Penthouse AHU